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Khalid, Md. Saifuddin; Sujan, Khaled Mahmud; Haque, Indrani

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An Empirical Study on the Effect of Different Technology Environments on Students' Assessment

Md. Saifuddin Khalid, Khaled Mahmud Sujan*, Indrani Haque**

School of Engineering & Computer Science (SECS)

Independent University, Bangladesh (IUB),

Dhaka, Bangladesh

E-mail: professorsorkhalid@gmail.com, sujandk@gmail.com*, indranihq@gmail.com**

Abstract—Multiple choice question (MCQ)-based assessment for higher education students can be a solution to reduce workload where teacher-student ratio is significantly high and also in distance learning approaches. Originating from the users problem claiming that “web-based and mobile-based tests are inconvenient and does not allow expected performance”, this research poses the question, “Does use of different technology environment has any positive or negative effect on the students’ assessment or performance?” To seek answer to this question, students of three sections of a private university in Bangladesh attended MCQ tests under the same instructor’s lecture and appeared for the tests using paper-based, web-based and mobile SMS-based testing systems. Results of such tests are analyzed. The variance test shows that paper-based, web-based and mobile-based test scores do not vary. Problems experienced in implementing such web-based and SMS based system in Bangladesh are discussed. In Bangladesh, some telecentres has been established by government and NGOs which are engaged in educating people in the rural and remote areas of the country. This low-cost SMS-based testing can be used for testing trainees of these telecentres and assessment can be centralized, if uninterrupted power supply can be ensured, contents can be shared and tests can be arranged through the web-based LMSs.

Keywords—E-learning, Assessment, learning technologies, Learning Management Systems (LMS)

I. INTRODUCTION

Since 2000 Internet and mobile phone users started increasing rapidly in Bangladesh, opening the scope of effective e-learning and m-learning in Bangladesh. International Telecommunication Union (ITU) report about the Internet usage and population statistics [1] is shown in Table 1.

TABLE 1. INTERNET USAGE AND POPULATION STATISTICS

YEAR	Users	Population	% Pen.	Usage Source
2000	100,000	134,824,000	0.1 %	ITU
2007	450,000	137,493,990	0.3 %	ITU
2010	617,300	158,065,841	0.4%	ITU

In Bangladesh, computer and Internet service are relatively costlier and satisfies less basic requirements of communication, mobile phone being cheaper and capable of satisfying more communication requirements could penetrate greater and is spreading in a faster rate. An online article [2]

of Reuter (Thu May 15, 2008) was published on the topic “Cellphone users in Bangladesh on the rise.” This news reported, “Bangladesh's six mobile phone operators added 1.41 million new subscribers in April, lifting the user base to 40.34 million, the Bangladesh Telecom Regulatory Commission data showed on Thursday. The number of mobile users rose nearly 58 percent in 2007 to 34.4 million, the telecoms regulator said, helped by competitive tariffs and cheap handsets. Several market surveys have forecast the number of mobile phone users will be around 70 million at the end of 2011. [2]” Bangladesh Bureau of Statistics report of 31 May 2010 showed this count as 56.43 million.

Advancements in information technology, coupled with the changes in society, are creating new paradigms for education and training. These massive changes have tremendous impact on our educational and training systems. Participants in this educational and training paradigm, require rich learning environments supported by well-designed resources [3]. While self-paced learning and habit has grown with traditional learning content, reliable and convenient ICT-enabled assessment process has to be developed. Considering affordability and e-readiness traditional paper-based assessment has to be available with web-based and mobile-based educational assessment. For high teacher-student ratio in higher educational institutes, especially in Bangladesh, e-learning can facilitate reducing workload of assessment and ensuring learning content access.

A. What is E-Learning?

Internet and digital technologies have become a powerful, global, interactive, dynamic, economic, and democratic medium of learning and teaching at a distance [4]. The Internet and mobile phone services provide opportunities to develop learning-on-demand and learner-centered instruction and training. There are numerous names for online learning activities, including e-learning, Web-based learning (WBL), Web-based instruction (WBI), Web-based training (WBT), Internet-based training (IBT), distributed learning (DL), advanced distributed learning (ADL), distance learning, online learning (OL), mobile learning (or m-learning) or nomadic learning, remote learning, off-site learning, a-learning (anytime, anyplace, anywhere learning), and so on.

In this research, the term e-learning is used to represent face-to-face learning supported by web-based learning content availability using open source learning management

system “moodle” [5] and assessing students using paper-based, web-based and mobile-based testing systems.

B. Motivation and Scope

Most of the empirical researches in Bangladesh and the third world countries concentrated on the better ways of learning content and experience sharing. However, while technology solutions are readily available to make technology enabled test assessment system, significant amount research has not been conducted questioning coexistence of face-to-face and online learners in a learning environment and the adaptability to enable convenience for relatively new technology adopters. It is a fact that in the face-to-face learning environment, there is scope to have online test, mobile phone assisted tests, parallel to paper-based tests. These technologies will facilitate instructors to save their time to prepare questions and make copies of those, later checking and tabulating those. For a large-size student group, this is a time consuming and hard task. Wrong entry of student score is a very frequent error. Therefore, these can be reduced by an online test. While such approaches shall probably be found feasible, this research focuses on the assessment question.

Multiple-choice questions (MCQ) and true-false questions can be easily assessed by a technology enabled system. GRE, SAT, TOEFL etc. are widely accepted MCQ tests and these are computer-based as well. This gave the motivation that in the regular face-to-face class room environment it is possible to use technology tools and such will be widely accepted. Technology agents shall be able to reduce workload from the instructor, even in a face-to-face environment.

Apprehending the Bangladesh’s power insufficiency and frequent load-shedding, making computer and Internet access less effective for e-learning applications, government needs to ensure uninterrupted electricity and Internet access. While computer and Internet based assessment process depends largely on electricity availability, SMS-based system does not. Moreover, since there are more cell phone users, there will be a larger target group of e-learning.

Different Learning Management Systems (LMSs) are used as effective web-based applications, by different academic and training oriented organizations all over the world. Instead of developing one application from scratch, it would be best to use one of the open source LMSs based on a software evaluation study. These LMSs bear all the positive features of any open source application which are freely and frequently tested and patched by volunteers worldwide. For this research LMS “moodle” [5] was selected.

Khan, in his book on e-learning framework, included “evaluation” and “technological” in two different facets of his e-learning framework, but their relationship was not addressed [6]. Student assessment is a part of evaluation process. This research therefore poses this question “does use of different technological environments has any effect on the students’ assessment or performance?” If content delivery is constant, do web-based, mobile-based and paper-based test results vary for multiple choice question tests? Since educational evaluation is an integral and inseparable

part of teaching-learning process, alteration of traditional practice should be justified. In this case we presume that due to the required time for adaptation to technology change in the process, it might degrade the performance during test.

C. Objective

The general objective of this research was

- to develop technology agents to use web-based and mobile-based test environments for students of tertiary level of education and for in course tests.
- to identify the effect of the technological environments on students’ test scores.

II. REVIEW OF LITERATURE

A. A Framework for E-Learning

Traditional classroom-based instruction takes place in a closed system (i.e. within the confines of a given classroom, school, textbook, or fieldtrip), whereas e-learning takes place in an open system (i.e., it extends and the boundaries of learning to an open and flexible space where learners decide where and when they want to learn) which brings more factors in consideration [6]. Eight dimensions of e-learning framework include: institutional, management, technological, pedagogical, ethical, interface design, resource support, and evaluation [6]. Various issues within the eight dimensions of the framework were found to be useful in several studies that were conducted to review e-learning programs resources and tools ([7]-[20]). Based on these, this research addresses the issue of “student evaluation” only. The researcher believes that the e-learning framework’s all factors cannot be addressed together in direct conversion approach. Rather the traditional f2f system can be made more efficient in management and monitoring, with the use of web-based and mobile-based features. With this vision in view, this empirical research conducts “assessment of learners” under “evaluation” sub-dimension of e-learning framework (table 2) taking different technological opportunities in consideration.

B. Assessment of Learners

This research includes study on assessment of learners. Khan summarized that assessment pertains to authenticity, reliability, formats (e.g., multiple choice, essays, case studies, electronic portfolios, etc.), and test characteristics (e.g., adaptive and randomized) [6]. A variety of evaluation and assessment tools can be incorporated into an e-learning course. Individual testing, participation in group discussions, questions, and portfolio development can all be used to evaluate students’ progress. Assessment in e-learning should be congruent with the pedagogical approach of the course.

Considering the open and flexible nature of the e-learning environment, assessment of learners at a distance can be a challenge. Issues of cheating are a major concern [21]. Questions such as: “Are students actually doing the work?” [22] and “How do we know we are assessing fairly and accurately?” [21] will always be of concern for online-learning environments. Therefore, this research reduced this gap by arranging proctored test, i.e. tests are held in the presence of an examiner in class.

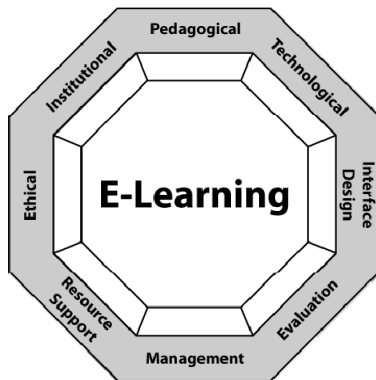


Figure 1. The e-learning framework [6]

TABLE 2. SUB-DIMENSIONS OF THE E-LEARNING FRAMEWORK

INSTITUTIONAL	PEDAGOGICAL	INTERFACE DESIGN
Administrative Affairs Academic Affairs Student Services	Content Analysis Audience Analysis Goal Analysis Design Approach Instructional Strategies Organization Blending Strategies	Page and Site Design Content Design Navigation Accessibility Usability Testing
MANAGEMENT	ETHICAL	RESOURCE SUPPORT
People, Process and Product Continuum Management Team Managing E-Learning Content Development Managing E-Learning Environment	Social and Cultural Diversity Bias and Political Issues Geographical Diversity Learner Diversity Digital Divide Etiquette Legal Issues	Online Support Resources
TECHNOLOGICAL		EVALUATION
Infrastructure Planning Hardware Software		Evaluation of Content Development Process Evaluation of E-Learning Environment Evaluation of E-Learning at the Program and institutional Levels Assessment of Learners

III. METHODOLOGY AND HYPOTHESES DEVELOPMENT

A. Methodology

1. Test schedule planning, preparation and distribution
2. Sample selection: During autumn 2007, August to December, three different sections of probability and statistics course offered to business, communication and environment major students of Independent University, Bangladesh (IUB) were selected for this study.
3. Target group e-readiness survey: Out of 123 enrolled, 104 (65% male, 35% female) participated in the survey and attended tests. 98% know "how to use" a computer, 90% "own a desktop," only 6% do not have internet access at home, 98% students "own a mobile" and 96% "use SMS".

4. Test schedule planning, preparation and distribution: A test schedule was prepared including nine quizzes, each quiz on a separate chapter of the text book, carrying 35% marks where the rule was set that best 7 quizzes will be counted. Standard multiple choice test question preparation
5. Students' approval for SMS based quiz. Student consent paper was signed by each student for using personal cell phone for academic information and data analysis.
6. Class room lecture and content sharing methods: Learning Management System "Moodle" was used.
7. Paper-based, Web-based, SMS-based question preparation and test environment
8. Preparation of the SMS parsing agent: A third-party SMS gateway was used for forwarding all SMS irrespective of operator being used by the student.
9. Preparing SMS authentication system: Student mobile numbers were stored against their ID and name in the SMS agent
10. Data collection: Student scores were exported from the LMS and SMS parsing agent

B. Hypothesis Development

Mobile, web and paper-based tests can be conducted in parallel if three different technologies do not hamper the test score. Analysis of variance is used to test for the equality of k population means. Where $k = 3$.

$$H_0: \mu_1 = \mu_2 = \dots = \mu_k$$

$$H_a: \text{Not all population means are equal}$$

In this case, the null hypothesis is $H_0: \mu_P = \mu_W = \mu_M$ where, μ_P = population mean of paper-based test scores, μ_W = population mean of mobile-based test scores, μ_M = population mean for web-based test scores.

1. SMS-based testing System Process and Parsing Flow chart

Figure 2 shows the SMS-based testing system process. Each SMS originating from students' mobile handsets and through different mobile operators, pass through their own MSC and SMSC. Using different protocols including CIMD, SMPP etc. these arrive at the SMS gateway. This SMS gateway handles these different protocols to communicate through the HTTP protocol. These SMSs are then directed to SECS server hosted URL. The SMS parser in the directed SECS URL uses appropriate function and sends a reply SMS to the gateway as a response to the received one. The SMS gateway then forwards this resulting SMS to the sender.

IV. DATA ANALYSIS AND RESULTS

A. Summary of Test Scores

Students from three different sections appeared for nine multiple-choice tests as shown in table 4.

B. Analysis of Variance: Testing for the equality of k population means

An Analysis of variance test is conducted on these scores for testing the equality of k population means. Here, overall sample mean is 5.5. Therefore, if the null hypothesis is true (the overall sample mean of 5.5 is the best estimate of the population mean μ).

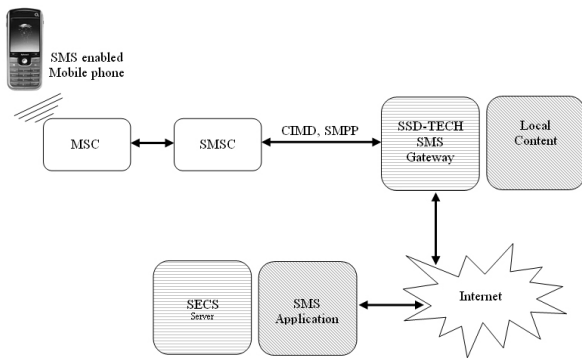


Figure 2. SMS-based testing system process

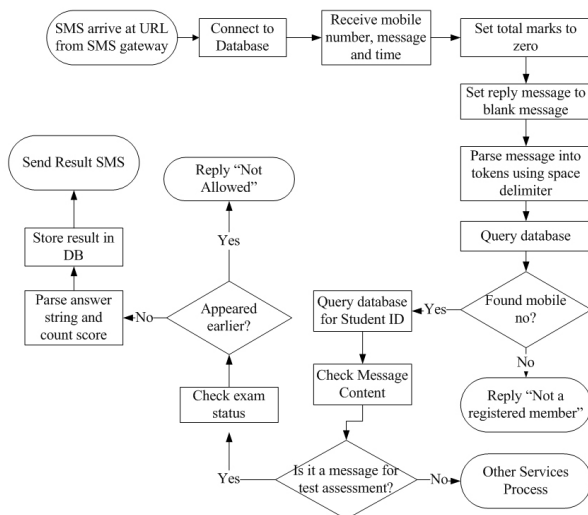


Figure 3. SMS Parser flowchart for SMS-based System

TABLE 4. SUMMARY SCORES OF DIFFERENT TECHNOLOGY USERS

Quiz	Paper based	Web based	Mobile based
Sample mean	5.5	5.4	5.6
Sample variance	0.84	1.21	1.74
Sample standard deviation	0.91	1.10	1.32
Coefficient of Variation	16.54%	20.37%	23.57%

Considering table 5 and the rejection rule the conclusion is “do not reject.” Therefore, we have sufficient evidence to introduce these technologies in quizzes for the studied group

of students or students of similar background admitted in this university.

TABLE 5. ANALYSIS OF VARIANCE TABLE

Source of Variation	Sum of squares	Degree of Freedom	Mean Square	F
Treatments	0.18	2	0.09	0.07
Error	30.28	24	1.26	
Total	31.40	26		

C. Problems Experienced with Application of Web-based Assessment System

- Unavailability of power supply was a major problem in conducting the web-based testing in a computer lab setting.
- Availability of uninterrupted Internet connection during the test had to be ensured.
- Students used to forget their password and did not have their email accounts activated to get the new password either.

D. Problems Experienced with SMS-based Assessment System

- In some cases students did not get any reply after sending their SMSs due to one mobile operator's different process.
- 4.54% of the SMS were resent intentionally by the students by altering their answers in the answer string. This can be considered as an attempt to adopt unfair means. However, for sending multiple SMS students were not penalized during this study.
- 4.34% (2 out of 46) students had to appear at least one test on papers instead of SMS as they lost their cell phones. In such case paper-based test was accepted.
- Astonishingly 24% (11 out of 45) students changed their SIM card and did not notify.

E. Students' Attitude Towards Mobile-based Testing

- It is seen that students are usually keen to know their results as soon as possible despite the time it takes them to finish the quizzes. In that respect the Cell-phone based system is quite popular among the students.
- For a number of students using this “system” was about trying something new which interested them.
- Independence from power supply issue relieved students.
- Arranging the answers serially was not liked by some of the students. Confusions rose if they did not know any answer to questions some where in the middle.
- Some students did not feel comfortable about following a format while sending a text message during the quiz.

V. CONCLUSION AND RECOMMENDATIONS

A. Findings

In a face-to-face learning environment, these three different technologies may be used in parallel for university students in Bangladesh, with similar e-preparedness or e-readiness as briefly described in methodology step 3. These tests can be proctored at the telcenters or labs. Students do not necessarily have to own a technology, rather have to know how to use it.

B. Frequently Asked Questions in designing this research work

1. How the students may attempt to adopt unfair means in SMS-based assessment and how it can be checked? Answer: Firstly, a student may send his SMS to another student to share the answers. For this research each test included three sets which are then shuffled to prepare seven sets of questions. Each question was assigned a unique set number to discourage students from looking for same set receiving student. Secondly, A student may change the answer string to correct some of the answers and resubmit. For this case, only first submission is accepted and any subsequent SMS sent for the same quiz is discarded.

2. How the students may attempt to adopt unfair means in web-based assessment and how it can be checked? Answer: Students can cheat by using other's password and sit for other's test, they might consume more time if time tracking is not activated, student may be assisted by someone else if the test is not proctored. Each test was password protected and tests were proctored tests, a time tracking was activated each time an exam was taken, count-down timer shows the duration remaining. A student must submit the answer within deadline, else the answer would be rejected and 0 score would be awarded.

C. Recommendations

Instructors and students should be trained to manage and use the LMS and cell phone for testing. Instructors have to be trained to set the correct answer string in the mobile-based system and configure quiz questions for the students.

D. Scope of Future Work

In future, policy and procedure could be developed for application of similar assessment systems for open, flexible and distributed learning environment. In Bangladesh, some computer-based information centers, named Community Information Center (CIC) of Grammenphone [23], similar other computer-based telecenters of D.Net [24], YIPSA [25] and A2I projects [26] are engaged in educating people in the remote areas of the country. This SMS-based testing can be used for conducting proctored tests at these telecentres and assessment can be centralized. Most of the professional skill building tests are presently objective type questions. Therefore, these tele-centers can use the web-based system for virtual classroom, content management and also for testing. If low cost laptops can be arranged with wireless internet connection, power failure problems can be avoided for ensuring uninterrupted online tests.

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